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ABSTRACT

As a consequence of studies indicating that students' ability to think can be improved through direct instruction, this booklet presents one approach to teaching thinking skills within the context of existing curricula--a model described as the "inclusion process." The booklet discusses what thinking skills should be taught and how to decide which skills are appropriate. It then describes four approaches for teaching thinking skills: infusion, a separate course, linkage, and inclusion. Next, the booklet describes using the inclusion process and guidelines for teaching thinking skills using focus and application lessons. The booklet concludes by discussing the universality of the inclusion process, evaluating thinking skills instruction, and advocating a focus on process rather than content. (EL)

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A Model for Teaching Thinking Skills: The Inclusion Process

Antoinette M. Worsham
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PHI DELTA KAPPA
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Worsham's doctoral research dealt with the direct instruction of thinking skills. Since 1983 she has been developing the "Inclusion Process" model of teaching thinking skills featured in this fastback. This model is currently being used in four Maryland counties. Worsham also has conducted inservice programs demonstrating the model in Maryland and several other states.

Anita J. Stockton is a science specialist for the Maryland State Department of Education. She has taught chemistry and biology in Connecticut, Florida, and Maryland. She earned her B.S. from the University of Connecticut, an M.S. in science education from the University of Georgia, and an Ed.D. from the University of Maryland in curriculum and supervision.

Stockton's doctoral research was an ethnographic study of science classrooms. One of her major findings is that students prefer actively constructing knowledge to merely absorbing facts. This led naturally to her interest in thinking skill instruction. While teaching chemistry and biology, she developed curriculum materials for the specific teaching of thinking skills.

Series Editor, Derek L. Burleson

A Model for Teaching Thinking Skills: The Inclusion Process

by
Antoinette M. Worsham
and
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Why Teach Thinking?

The most critical issue facing educators today is students' lack of adequate thinking skills for solving problems and making decisions. Although research has shown that nearly all students beyond the age of 12 should be able to reason at the formal operational level (Piaget 1972), fewer than 40% of high school graduates are able to demonstrate higher-level thinking skills (Day 1981). This is not due to low intelligence but rather to students' inability to apply the higher-level skills and processes necessary for many curricular tasks (Makler 1980).

The problem is compounded when the approach to instruction assumes that students are receptacles of knowledge and that there is a specific body of knowledge that students should assimilate. Studies of classroom instruction show that most content is presented at the knowledge level. Studies also show that the ratio of teacher talk to student talk is three to one, with only 1% of this teacher talk requiring students to engage in anything beyond recall (Goodlad 1983). This approach to instruction assumes that the "correct answer" is the ultimate curricular goal. As a result, students have little opportunity to exercise their reasoning skills. They become passive receptacles rather than active manipulators and generators of knowledge.

The National Assessment of Educational Progress (NAEP) has found that many students are unable to solve word problems on standardized mathematics tests. They cannot translate the information provided in

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the word problem into the algorithm needed to do the computation, even though they know how to do the computation. They lack the thinking strategies to change words into the appropriate mathematical process to solve the problem (NAEP 1979).

More than 25 years ago the Educational Policies Commission (1961) stated,

> The purpose which runs through and strengthens all other educational purposes – the common thread of education – is the development of the ability to think.

But it has only been in the 1980s that educators have given serious attention to how to teach thinking more effectively.

Studies indicate that the student's ability to think can be improved through direct instruction (Whimbey 1980; Worsham and Austin 1983). Whimbey's research in cognitive skill development indicates that if students are taught basic thinking skills and given practice in their use, their overall ability to think and solve problems will improve. Worsham (1982) showed that students who were given focused instruction in thinking skills as part of their English curriculum scored an average of 42 points higher on the verbal portion of the SAT than a control group that did not have direct thinking skill instruction.

To master many curriculum objectives, students need to use several higher-order thinking skills. Teaching these skills must be deliberate and continuous if the students are to *learn how to learn*. Time is required, time to *think* and time to *talk* about thinking. This time pays off. Once students become proficient in using various thinking strategies, they will use them in all areas of the curriculum.

This fastback presents one approach to teaching thinking skills – a model developed by one of the authors (Worsham) and currently used in several Maryland counties. There are other worthwhile approaches, but we believe the "Inclusion Process" described in this fastback is an effective way to begin teaching thinking skills because it provides for the direct teaching of these skills within the context of the existing curriculum.

What Thinking Skills Should We Be Teaching?

The growing body of literature on the teaching of thinking overwhelms us with such terms as prerequisite skills, process thinking, conceptual thinking, thinking levels, higher-order thinking skills, lower-order thinking skills, creative thinking, critical thinking, problem solving, and decision making. As one reads the literature, it becomes apparent that the same terms used by one writer have different meanings when used by another writer. There is a need for those working in this field to agree on definitions, but until that happens we have defined those terms we feel are necessary to understand the concepts presented in this fastback.

Thinking is an internal process unique to each person, which can not be defined as a concrete entity. It must be defined in abstract terms. We define thinking as the mental manipulation of sensory perceptions to formulate thoughts, knowledge, reasons, or judgments. The two broad categories of thinking are critical thinking and creative thinking. Critical thinking involves the manipulation of sensory input in order to generate meanings and interpretations. Creative thinking involves several processes resulting in novel or aesthetic ideas or products. In the critical mode the thinker is acting on some external content such as a piece of literature, a chart, or a mathematical problem. In the creative mode the thinker is actively producing something such as a poem, a visual illustration, an oral report, a research paper, or a three-dimensional construct.

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Complex thinking processes include problem solving and decision making. Although similar, the two processes differ somewhat. Problem solving uses thinking skills to resolve a known or defined difficulty. It involves several steps including: 1) defining the problem, 2) collecting data concerning the problem, 3) forming hypotheses, 4) testing the hypotheses, 5) forming a conclusion, 6) applying the conclusion, and 7) evaluating the conclusion. These steps are the same as the scientific method.

Problem solving requires applying specific thinking skills to solve a problem. Consider, for example, the skills needed to plan a balanced budget. Research shows that good problem solvers have a large repertoire of skills and are flexible and inventive in applying them.

Decision making involves the thinking skills needed to choose the best response from several options; for example, selecting which income tax form to use for the best tax advantage. It entails the comparison of advantages and disadvantages of alternate approaches. It involves several steps including: 1) defining the problem, 2) collecting data, 3) identifying obstacles to the goal, 4) identifying alternatives, 5) ranking alternatives, 6) choosing the best alternative, and 7) evaluating the decision.

Bloom (1956) has developed a taxonomy of six thinking levels. They are: knowledge, comprehension, application, analysis, synthesis, and evaluation. Progression through these levels requires increasingly complex thinking skills in almost endless combinations. For each of these six thinking levels, there are discrete, identifiable skills that can be defined and broken down into a logical sequence of steps. These skills can be practiced individually and then used in combination with other skills to attain specific learning objectives. For example, if students are expected to comprehend specific curriculum content, they can demonstrate their comprehension in a variety of ways (constructing a diagram or graph, writing a letter to a friend, or giving an oral explanation).

Persons who can apply a variety of thinking skills generally make better decisions and solve problems more effectively. Those who have skills that allow them to visualize the consequences of their decisions usually can make better decisions. Mark Twain has said that if the

only tool one has is a hammer, everything is treated like a nail. The same holds true for thinking skills. The fewer we have, the less we are able to think effectively.

Thinking skills, then, are processes used by the learner to operate more effectively at various thinking levels. They are not the same for each learner. That is, learners do not all use the same steps to accomplish a task. However, there are some skills that are basic and common to most curriculum tasks (for example, gathering information, finding the main idea, determining meaning).

Deciding Which Skills Are Appropriate

In teaching thinking skills, the first task is determining which skills are appropriate at a particular grade level and for specific course content. It is generally agreed that it is better to teach a few skills well than to cover many superficially. Some suggest that specific skills be taught at specific grade levels or in specific subjects. We believe the most useful approach is to analyze the requirements of the curriculum and the cognitive needs of the learner to determine which skills need to be taught *explicitly*.

The elementary grades generally are seen as appropriate for emphasizing the lower-order thinking levels of knowledge, comprehension, and simple application. These involve such thinking skills as identifying the main idea and applying this information in understanding the plot of a story. The skills introduced in the elementary grades generally build vertically on one another. However, elementary students also are able to engage in more complex critical reasoning skills if the content is appropriate to their level of understanding. For example, younger students are able to make valid predictions within their realm of experience, even though prediction is generally considered to be a higher-order thinking skill.

Middle school is probably the most appropriate place for intensive development of higher-order thinking skills. Most middle school students are making the transition from concrete to abstract reasoning. Curriculum requirements generally are flexible enough to lend themselves to a variety of skills across the curriculum; for example, as-

sessing the validity of advertising claims in social studies, hypothesizing the outcome of an experiment in science, or interpreting the actions of characters in a story in English. Also, those skills introduced in the lower grades should be refined and reinforced.

If students acquire a wide variety of skills in elementary and middle school and have many opportunities to practice them in various parts of the curriculum, they will be ready to apply these skills in high school. Most curriculum materials at the high school level require that students analyze, synthesize, and evaluate as well as to create new "products," such as original oral and written pieces and artistic creations. Students are expected to apply the appropriate thinking skills to accomplish these tasks. They are expected to think critically and creatively about social issues, community problems, science experiments, and literature.

The placement of thinking skills at a specific grade level is difficult. While most materials in the primary grades involve recognition and recall, some analysis is necessary for comprehension. For example, young students may be asked to examine a group of objects and distinguish between living and nonliving things. This seemingly simple task requires a definition of terms, a listing of the attributes of living and nonliving things (classification), and then a comparison of these attributes with the attributes of those objects being studied. These tasks require analysis at a simple level; nevertheless, it is analysis.

Likewise, young students must synthesize simple ideas in order to comprehend larger concepts. Once students have mastered the larger concepts, they can *apply* them to other situations. So the skills move on both vertical and horizontal axes throughout the grades.

In deciding which skills are appropriate, it is necessary to consider both the needs of the students and the requirements of the curriculum. By asking, "What curriculum materials do my students struggle with each year and why?" we can identify those skills that learners need to accomplish curriculum objectives. These are the skills that must be taught *explicitly* and *directly*.

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Methods for Teaching Thinking

There are four basic approaches to teaching thinking skills. While not mutually exclusive, these four approaches are:

1. Thinking skills are already *infused* throughout the curriculum and need no further emphasis.
2. Thinking skills can be added to the curriculum as a *separate course*.
3. A scope and sequence of thinking skills can be developed and *linked* to the existing curriculum.
4. Thinking skills can be taught explicitly and *included* as part of the curriculum based on course requirements and student needs.

Infusion

Evidence indicates that whatever infusion of thinking skill instruction currently exists in the curriculum does not go far enough. Recent research data (NAEP 1982) show a decline in student reasoning ability, calling into question the assumption that thinking and reasoning skills are effectively infused throughout the curriculum.

Separate Course

Adding a separate course is another alternative to improving thinking skills within existing curricula. Several commercial programs de-

veloped to improve students' ability to think and reason are currently available. These range from specially written stories for elementary students (see fastback 206 *Philosophy for Children: An Approach to Critical Thinking*) to those based on logic and socratic reasoning suitable for older students. Several programs are remedial, designed to help middle and high school students in those skills required to pass a minimum compentency test. Most commercial programs require instructional time apart from the regular curriculum as well as extensive inservice training and follow-up coaching for teachers.

Linkage

The linkage approach to the teaching of thinking skills uses an articulated scope and sequence of skills, which are then linked to the existing curriculum, with specific skills taught at grade levels where they are judged appropriate.

Inclusion

The "Inclusion Process," the approach advocated in this fastback, is a direct instruction model that first considers the objectives of a curriculum and the needs of the learner and then identifies the cognitive skills necessary to attain those objectives. By analyzing the sophistication of the thinking processes needed, one can determine the thinking skills that should be explicitly taught either separately or in clusters. Thus the model provides a structured procedure for learning the skills and using them to achieve mastery of the required curriculum. The process includes eight steps:

1. Analyzing the curriculum objectives to determine the thinking categories, processes, or levels required to master the curriculum.
2. Assessing learners' cognitive needs with regard to the curriculum objectives.
3. Developing, based on curriculum requirements and students' cognitive needs, a list of thinking skills to be taught.

4. Developing a long-range plan for sequencing thinking skills instruction in introductory focus lessons and follow-up application lessons.
5. Defining each skill.
6. Listing the steps involved in applying each skill.
7. Applying the skills to the curriculum.
8. Testing for effective skill application.

These eight steps are discussed more fully in the next section.

Using the Inclusion Process

Of the various approaches to teaching thinking skills, we believe the Inclusion Process is the most useful for the following reasons:

- It begins with an analysis of the curriculum to be taught.
- It allows the teacher to select, based on student needs, the skill to be included as part of the curriculum.
- It provides a methodology for both teacher and student to learn the selected skills.
- It provides direct and immediate practice of the skill in the content being taught.
- It requires that the application of the skill be evaluated along with the content taught.
- It provides a model for teaching thinking skills that can be applied and repeated across all grade and content areas.
- It requires no additional funding beyond some initial inservice training (although on-going coaching is highly useful).
- It can stand alone or be used with any of the other approaches.

The Inclusion Process, then, provides a way for any teacher to *begin* and to *continue* to teach students how to think more effectively.

Analyzing curriculum objectives to determine the categories and levels of thinking required. The content of most courses requires that students be able to operate on many thinking levels, from simple

information gathering and literal comprehension to higher-order analysis, synthesis, and evaluation. An analysis of the curriculum's cognitive demands provides the teacher with a good indication of the degree of thinking sophistication necessary to master the content. For example, a high school literature course requires continuing use of analysis, synthesis, and evaluation skills, while a typing course requires recall, rote learning, and repetitive practice.

Assessing the learner's cognitive needs with regard to the curriculum objectives. Any teacher who has taught a course more than once can identify readily those skills and concepts that most students will have difficulty learning. By identifying these "rough spots" in the curriculum, the teacher can anticipate and prepare for those general areas where students need more explicit cognitive skill instruction and direct assistance.

Developing a list of thinking skills to be taught. By identifying what parts of the curriculum are difficult for students, the teacher can narrow the focus to specific thinking skills that should be taught *directly.* Various writers have developed lists of thinking skills ranging in length from as few as six to as many as 120. Those selected for direct teaching should be based on individual program requirements and the needs of a specific group of learners. Teachers should exercise restraint in the *number* of skills selected. It is better to focus on a few skills (four to six a year) than to attempt to teach all the skills that students will eventually need to learn.

Developing a long-range plan for the sequencing of thinking skills. Just as a long-range scope and sequence plan is developed to ensure that the content is covered, so, too, should the thinking skill instruction be planned. In planning, each skill should be considered in relation to other skills to determine if a logical sequence exists. For example, recognizing cause-and-effect relationships should be taught before predicting outcomes. However, with higher-order thinking skills (predicting outcomes, determining alternative actions, assessing generalizations) the relationship of one to another is more horizontal than vertical. Therefore, it makes little difference which is introduced first. Each skill should be taught immediately prior to that portion of the curriculum requiring its application. Also, each skill should be

reviewed and reinforced several times at appropriate places in the program throughout the year.

Defining each skill. Before a thinking skill can be understood it must be defined by both the teacher and the student. The process of defining in itself is a thinking process requiring thoughtful analysis. It is just as important for the students to go through the defining process for each skill as it is for the teacher. Students can work in pairs or small groups to generate working definitions. Then, after sharing their ideas with the whole class, students refine their drafts until a single definition acceptable to everyone evolves. Some sample teacher-made and student-made definitions developed with this process are included in a later section of this fastback.

Listing the steps involved in applying each skill. After the definition is agreed on, the next step is to develop a list of those mental procedures necessary to apply the skill. For example, if the thinking skill selected is "predicting outcomes" and the agreed definition is "to make some reasonable conjecture about what might happen based on known facts and past experiences," then a listing of steps necessary to predict an outcome might include the following:

1. Consider past experiences.
2. Collect data.
3. Search for logical patterns.
4. Look for cause-effect relationships.
5. Consider all possible alternatives.
6. Construct a statement concerning the unknown event based on the pattern of known events.
7. Test or evaluate the prediction (if possible).
8. Repeat the cycle (if necessary).

Applying the skill to the curriculum. Applying these steps to the actual content that requires the particular skill should follow immediately so that the students can see how well their steps work and whether modifications need to be made in their list of steps. Students should have numerous opportunities to employ the procedure in order to become proficient in applying the steps. Moreover, students should be given frequent in-class opportunities to articulate their awareness of

their own thinking about thinking. This can be done by writing in "Think" logs, by participating in small- and large-group discussions, and by sharing their thinking process awareness with peers in "Think-Pair-Share" formats (Lyman 1981).

Testing for skill application. Just as students demonstrate mastery of content with drills, quizzes, and teacher-made or standardized tests, so, too, should they be tested on thinking skill proficiency. Students should be tested on their ability both to define the skills and to list the steps. And they should be given many opportunities to demonstrate that they can apply the skills. Only to the extent that students both know and can apply the skills do they become useful learning tools.

In addition to teacher-made tests, both norm- and criterion-referenced standardized tests can be administered to determine student progress. These currently are available from several test-making companies and new ones are being developed. However, standardized tests should be examined carefully to determine whether they actually measure those skills being taught.

Guidelines for Teaching Thinking Skills Using Inclusion Process Lessons

The Inclusion Process involves two kinds of lessons: "focus" lessons and "application" lessons. Focus lessons introduce the skill by defining and listing steps appropriate for each skill (steps 5 and 6 of the model). Application lessons are content specific and require the direct application of selected skills to specific curriculum objectives.

Focus Lessons

Focus lessons are designed to lead students through the processes of defining and generating steps for applying selected skills. Only one skill at a time is introduced. The inductive approach is particularly appropriate for the focus lesson. If, for example, the skill to be taught is predicting outcomes, the teacher might begin by providing the students with a series of situations where prediction is possible without extensive research, such as the following:

What will the weather be like tomorrow?
Who will win the basketball game?
How will this story end?
When will the next earthquake occur in California?
What will be the U.S. population in the year 2001?

Without doing any extra data gathering, students might begin by brainstorming and drawing on their own background knowledge and experience to generate some tentative yet reasonable responses to the questions posed. Where students are not accustomed to this approach, teachers can first "model" the process for the entire class. Then the class can be divided into smaller work groups to try out the process. After the students have developed several predictions, the teacher asks them to describe the forecasting activity they were engaged in (defining the skill) and what mental steps they went through to arrive at their answers.

If students find it difficult to think about their own thought patterns, it is helpful initially to pair two students during the problem-solving segment of the lesson, with one student (the recorder) describing the process that the second student (the thinker) follows in order to make the prediction. Then the definitions and listings of steps generated by pairs of students are compared for similarities and differences. Further discussion with the whole class usually results in a definition and list of steps acceptable to everyone.

Following are definitions and a list of steps generated by two groups of sixth-grade students during focus lessons.

Thinking Skill:
Reading Charts, Graphs, Tables, and Cartoons.

Definition (as developed by an above-average group):

Reading a chart, graph, table, or cartoon means to look at information, analyze it, define key vocabulary, and get a clear picture of the main idea for interpretation.

Steps:

1. Look at the information.
2. Analyze and break down numbers, headings, characters, colors, shapes, titles, maps.
3. Define key or difficult words.

4. Ask specific questions.
5. Find the main idea in your own words.
6. Interpret the findings.

Definition (as developed by a below-average group)

Reading a chart, graph, table, or cartoon means to look at information, see comparisons, define key words, and express the main idea in your own words.

Steps:

1. Look at the information.
2. Identify characters, numbers, terms, and maps.
3. Study the key if there is one.
4. Define words that you don't know.
5. Compare and contrast.
6. Find the main idea in your own words.
7. Ask "why" questions.

Definition: (as developed by the four teachers of these students)

Reading tables, charts, graphs, and cartoons requires the analysis of numbers, symbols, pictograph characters, colors, etc., for the purpose of interpretation.

Steps:

1. Study the content carefully.
2. Define key terms, concepts, vocabulary.
3. Identify the main idea(s), theme(s), or message(s).
4. Break down components and identify.
5. Determine relationships among terms, concepts, vocabulary.
6. Develop sample questions to test relationships.
7. Make generalizations based on the data.

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From the examples given, one can see that, although the definitions and steps differ somewhat in how the students and teachers express their ideas, the integrity of the process remains intact. Again, both students and teachers must work through steps 5 and 6 in the model in order to come to a common understanding of the skill to be learned.

Generally, focus lessons take two or three class periods. It is most important that students generate the definitions and steps and that adequate *think* time is given for both individual and group thought development and idea building. The teacher should not simply *tell* the students what the skill is, how it is defined, and how it is applied. The teacher's primary task is to foster a classroom environment that enables students to generate thinking.

Methods such as Think-Pair-Share (Lyman 1981), thinking about thinking (metacognition), brainstorming, and consensus building are most appropriate for focus lessons. Also, the teacher should use a variety of pairing and grouping techniques.

Some teachers find it helpful to have students set up a section of their notebooks titled "Thinking Skills." This section would include each skill taught directly, the class-generated definition, a listing of steps, and a log of those situations (both academic and nonacademic) in which the student has been able to apply the skill. Through regular entries in the log, students have a ready source to refer to when applying thinking skills in other subjects and in everyday life situations.

All focus lessons, then, have the same objective: to have students generate the definition and list of steps required to apply a specific thinking skill. Following is an example of such a lesson.

Sample Focus Lesson

Thinking Skill: Reading charts, graphs, tables, and cartoons.
Subject Area: Social Studies
Level: Middle School
Objectives: To construct a definition of reading charts, graphs, tables, and cartoons.
To describe the thinking processes involved in reading charts, graphs, tables, and cartoons.

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Materials: Overhead transparencies or several sets of charts, graphs, tables, and cartoons.
Student notebook section titled "Thinking Skills."

Procedures:

1. Present an example of either a chart, graph, table, or cartoon to the entire class.
2. Instruct students to study the data for a few minutes without talking or sharing ideas.
3. Pose the question, "What is this saying to you?" or "What does this mean?"
4. Choose a volunteer to record responses on the chalk board. Encourage all students to respond. In fact, choose students who do not raise their hands.
5. Repeat the procedure using different examples.
6. Ask students to offer explanations of what reading charts, graphs, tables, or cartoons means to them and use the chalkboard to synthesize students' ideas into a working definition.
7. Ask students to describe the steps (thinking processes) that they used for each example.
8. Make a class list of the steps involved in the reading of charts, graphs, tables, and cartoons.
9. Have students record the agreed-on definition and steps in the "Thinking Skills" section of their notebook.

Evaluation/Follow-up: Have students state the definition and steps in their own words. Using several examples of charts, graphs, tables, and cartoons, ask the students to apply the steps in order to read or interpret them.

Developed by David Reck, social studies teacher.
Patapsco Middle School, Howard County, Maryland.
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Application Lessons

Application lessons give students the opportunity to test their skill proficiency with specific curriculum content in various subject-matter areas. These lessons should follow immediately after the focus lessons.

Application lessons should be planned frequently throughout the school term to ensure that students are continually reviewing and reinforcing their proficiency in applying the thinking skill. The application lessons should provide students adequate time to think about thinking (metacognition) and to articulate their thinking processes. The teacher should use various pairing and grouping patterns for brainstorming and consensus building exercises. Students should record their thinking ideas, awarenesses, and experiences in logs or in the "Thinking Skill" section of their notebooks.

Regardless of the content being taught, there must be a heightened awareness that the skills involved in the thinking processes are valuable tools in learning. This is what education is all about: constantly improving our proficiency in applying an increasing number of complex thinking skills in a variety of ways in order to learn more effectively.

Following are examples of application lessons that require students to apply specific thinking skills to content areas.

Sample Application Lesson 1

Thinking Skill: Finding the main idea
Subject Area: Any
Level: Elementary or middle school
Objectives: To find the main idea in a short written paragraph by differentiating between supporting statements and the central focus of the passage.
Materials: Worksheet, chalkboard or overhead projector, selection of short paragraphs taken from appropriate printed materials and mounted on construction paper.
Procedures:

1. Explain to the class that the main idea of a paragraph is like an umbrella that covers all the ideas in the paragraph. Show illustration (see below).

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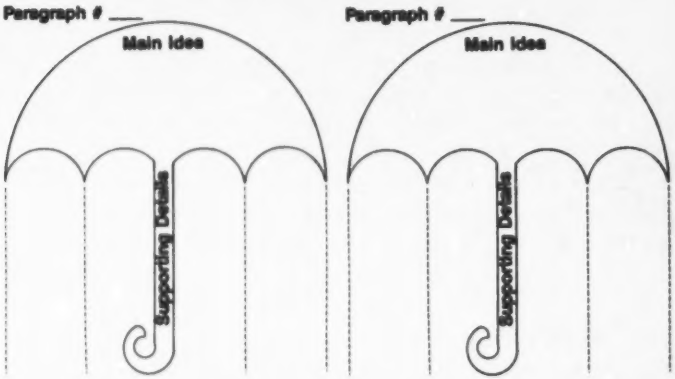
2. Have students work in small groups. Provide several examples of paragraphs. Number each to avoid confusion. Students will read three short paragraphs and record the main idea and the supporting details on the umbrella illustrations.
3. Allow a 10 to 15 minute work period and then ask each group to share its umbrella diagrams with the class.

Evaluation: Ask students to find a paragraph in a newspaper or a magazine and to put the main idea and supporting ideas on the umbrella diagram.



Developed by Bill Hodge, science and language arts teacher.
Thurmont Middle School, Frederick, Maryland.
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Sample Application Lesson 2

Thinking Skill: Recognizing relationships
Subject Area: Mathematics
Level: Elementary
Objectives: To generate ideas about number relationships.

Materials: Yardstick, scale, telephone directory, calendar, local community map, ZIP code directory, clock, thermometer, and any other articles to aid students in attaining the objective.

Procedures:

1. Set up several tables around the room and arrange three items on each table (yardstick, telephone directory, scale).
2. Pair the students and assign each pair to a table (several pairs can work at one table).
3. Tell student pairs to study the three items on their table carefully and discuss how they are used.
4. Give one or two examples for the entire group to get them started.
5. Tell each pair to make a list of how the items are alike or different with regard to their numerical functions. Allow five to seven minutes for this activity.
6. Have each pair share its list with the entire class.
7. Compile a class list of the relationships discovered.
8. Discuss the importance of numbers in everyday life.

Evaluation: Have each student select any two of the categories on the class list and write a brief explanation of the importance of these numbers in their lives.

Sample Application Lesson 3

Thinking Skill: Recognizing logical relationships

Subject Area: English language arts

Level: Middle school

Objectives: To recognize the logical development of basic story patterns.

Materials: Several comic pages of a newspaper.

Procedures:

1. Review the three major parts of a short story with the class (introduction, development, resolution). Point out that each part must build logically on the preceding one.

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2. Select one simple, three-frame comic strip that illustrates the pattern and ask students to identify the parts.
3. Distribute several comic strips in which the frames have been cut apart and are out of order.
4. Direct students, working in small groups, to arrange the frames in logical order, paste them on a sheet of paper, and label the major parts.

Follow-up: Have students construct their own comic strips with a story line that has an introduction, development, and resolution (it does not have to be funny). The completed student-developed strips can be displayed on the bulletin board.

Adapted from a lesson developed by
Anne Keilty, English teacher.
Patapsco Middle School, Howard County, Maryland
Used with permission.

Sample Application Lesson 4

Thinking Skill: Distinguishing between facts and inferences.
Subject Area: Science or social studies
Level: Middle school
Objectives: To distinguish between facts and inferences using pictures that depict the life of stone-age people.
Materials: Worksheet (see below) and several pictures depicting life of stone-age people.
Procedures:

1. Provide students with pictures that depict of the lifestyle of stone-age people.
2. Using the list on the worksheet, instruct students to place a check (✓) in front of those statements that are supported by information in the pictures and an (X) in front of the statements which are inferences.

Follow-up: In a class discussion ask students to justify their answers. Ask them to generate additional facts and inferences from the illustrations.

Worksheet for Lesson 4

Directions: Carefully study the illustrations depicting the life of stone-age people. Place a check (✓) in front of the statements below that are supported by the illustrations. Place an (X) in front of those statements that are inferences.

Stone-age people:

_____ hunted and gathered all their food.
_____ had no communication.
_____ found shelter in caves.
_____ made all of their own clothing.
_____ took care of their own medical problems.
_____ survived only by luck.
_____ fashioned all of their weapons by hand.
_____ built shelters from available materials such as sticks, grasses, and leaves.
_____ used clubs to attract a mate.
_____ demonstrated artistic ability by drawing and painting on cave walls.
_____ survived many ice ages while other species perished.
_____ were not interested in artistic expressions.

Using the statements that you think are factual, write a summarizing statement describing how stone-age people lived.

Adapted from a lesson developed by
Francis Baranson, science teacher.
Patapsco Middle School, Howard County, Maryland.
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Sample Application Lesson 5

Thinking Skill: Constructing definitions
Subject Area: English
Level: High school
Objectives: To learn the components of a definition. To develop a definition.
Materials: Dictionary

Procedures:

1. Have the students look up the word "definition" in a dictionary.
2. Organize students into small groups and have them:
   a) describe the components of a definition,
   b) develop some rules for writing a definition,
   c) look up two or three additional words of their choice and apply their rules to the definitions of these words,
   d) determine the validity of their rules,
   e) revise rules if necessary. Allow about 15 minutes for this activity.
3. Construct some plausible definitions for the following hypothetical terms using the dictionary for guidance and the rules developed by the group.
   aquadextrous (well coordinated in water)
   pseudophobia (false fear)
   quasirational (almost reasonable)
   terralunite (a moon creature living on Earth)

Follow-up: Create three original hypothetical terms and plausible definitions for each. Any logical definition based on the root, prefix, suffix, or derivation of each word should be accepted. The skill to be developed is defining.

Sample Application Lesson 6

Thinking Skill: Predicting
Subject Area: Social studies
Level: High School
Objectives: To predict which side will win the war between Persia and Greece (499-479 B.C) based on the analysis of a data chart.
Materials: Worksheet (see below)

Procedures:

1. Divide class into groups of three to four students. Have each group use the worksheet and respond to the questions, "Which side will win the war? How and why?" Allow about 10 minutes for this activity.
2. Have a student recorder write down the group responses. Share group responses with the entire class. (Most groups probably will predict that Persia will win the war. However, Greece won.)
3. Ask the total group what other variables (courage, determination, spirit) need to be considered in addition to measurable data when making predictions.

Follow-up: Ask each student to respond independently to any two of the following "What if?" questions:

What if:

1. the Ionian cities had not revolted in 499 B.C.? Would the Persian Wars have occurred? Why?
2. the Persians had won at Marathon?
3. a shepherd had not betrayed the Greeks at Thermopylae?
4. the entrance to Salamis Bay had been wider?
5. Sparta, not Athens, had the navy?

Use the following essay question (or a similar one) as a part of the final test for this unit.

How might a Greek soldier respond to an American colonist who asked, "Can we win the war for independence against Great Britain?"

Worksheet for Lesson 6

Directions: Study the data sheet carefully to determine which side will win the war. Complete the last column.

Topic	Greece	Persia	Which side has the advantage? Why?
Geography	Peninsula, mountainous, rocky, hilly soil	Huge land area that extends from Asia Minor on the west to India on the east and the Persian Gulf on the south. Contains rich farm land, mountains, plateaus, deserts, rivers.	
Natural Resources	Limited to those foodstuffs and metals found on the peninsula and those obtained through trade, few mineral deposits	Unlimited supply of agricultural goods, building materials, metals (including gold)	
Government	Varied, divided into city-states, types range from democracy to monarchy	Absolute monarchy	
Military	Athenian navy Army - forces contributed by each city-state	Huge mercenary army, navy	

Developed by Bonnie Erickson, Assistant Principal.
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Sample Application Lesson 7

Thinking Skill: Predicting outcomes
Subject Area: Biology
Level: High school
Objective: To predict whether an organism will survive in a particular environment using the knowledge gained in the study of cells, viruses, bacteria, and protists.
Materials: Worksheet (see page 34)
Procedures:

1. Working in groups, have students discuss the characteristics of each organism and predict whether it will survive.
2. Have a member of the group record the ideas generated.
3. Ask each group to share its predictions with the total class.
4. Have class discuss the steps involved in predicting.

Evaluation: Ask each student to design an organism that will survive in a specified environment.

Sample Application Lesson 8

Thinking Skill: Recognizing logical relationships
Subject Area: Mathematics
Level: Middle school
Objectives: To develop a rule of logical relationships by determining how many spots are on the three unseen sides of a die.
Materials: One die for each group of three to four students.
Procedures:

1. Each group rolls a die on a desk so that only three sides are visible. The group then tries to determine how many spots are on the unseen sides.
2. Each time the die is rolled, students should record data to develop a rule or rules for determining the number of spots on the unseen sides. If successful, the group should generate the following rules:

Worksheet for Lesson 7

Directions: Organisms present on earth today are built for survival. Using the knowledge gained in the study of cells, viruses, bacteria, and protists, predict whether each organism will survive in the environment described. Consider how the structures of each organism help it to accomplish its functions. Consider how the organism maintains homeostasis.

Organism	Structures	Environment	Steps used to solve the problem	Will or will not survive? Why?
#1	Large surface to volume ratio; has contractile vacuoles, membrane permeable to salt and water, cilia, eyespot, lacks chloroplasts but has food vacuoles	salt water with low oxygen content; lacks sunlight; has small population of microbes smaller than itself.		
#2	small surface to volume ratio; relatively large unicellular eukaryote, has flagella, chloroplasts, contractile vacuole; no eye spot.	fresh water, low oxygen content, sunlight		
#3	small eukaryote without pseudopods, cilia, or flagella; lacks food vacuoles but has contractile vacuoles	damp, dark forest floor; lacks sunlight; has numerous microbes smaller than itself.		

a) One is opposite six.
b) Two is opposite five.
c) Three is opposite four.
d) Opposite sides always total seven.

Follow-up: Following the same procedures, use an eight-sided die. Ask students to generate rules for how many spots are on the unseen sides. If successful, they should generate the following rules:

a) One is opposite eight.
b) Two is opposite seven.
c) Three is opposite six.
d) Four is opposite five.
e) Opposite sides add up to nine.

Adapted from a lesson developed by
Barbara Hoffman, mathematics teacher.
Patapsco Middle School, Howard County, Maryland.
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Universality of the Inclusion Process

The sample lessons in this fastback demonstrate how the Inclusion Process can be used in particular content areas. It has, of course, wider applications. The process can be applied schoolwide or systemwide to cover explicit instruction in all the thinking skills the curriculum requires. The wider the span of subjects and grade levels, the greater the prospects are for a sequential program in teaching thinking skills.

While students can profit from thinking skill instruction at any level, the middle school seems to be the most appropriate setting for intensified focus on the higher-order thinking skills. Most students at this age are developmentally ready to process formal operational thought required for higher-order thinking (Piaget 1972). Also, the middle school generally provides an interdisciplinary curriculum structure and a team staffing model, which permits a better coordinated and better integrated thinking skills program.

Evaluating Thinking Skills Instruction

The expenditure of time, energy, and funds for teaching thinking must be justified not only to boards of education and parents but to teachers and students as well. How do we judge whether these expenditures pay off? How do we determine if adding thinking skill instruction to the curriculum makes a difference? Clearly, evaluation must be an integral part of the thinking skills program.

Many standardized measures for assessing thinking skills already exist and certainly should be considered for measuring student progress. But other indicators also should be used. For example, student scores on standardized achievement or aptitude tests should be analyzed for indications of growth beyond predicted expectations. Also, school systems should develop their own tests to assess the specific skills being taught in their program.

In the classroom the teacher can be alert for other indicators beyond the student's demonstrated ability to apply a particular thinking skill to a curriculum task or on a final examination. Such indicators include:

- Increased student participation in classroom activities
- Increased student interest and enthusiasm for thinking/learning tasks
- Increased length of student oral and written responses

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- Higher-level thinking demonstrated in student questions and answers during discussions
- Evidence of increased ability to apply thinking skills in solving diverse problems
- Decreased student impulsiveness in responding, that is, thinking before speaking

Because of the complexity of the thinking process, it is difficult to measure improvement precisely. But if we truly believe that thinking skills are basic to all aspects of learning, then the lack of more precise indicators of progress should not deter us from attempting to improve the teaching of thinking.

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Conclusion

Traditionally the curriculum has been viewed as a body of knowledge with the focus on content rather than the process of thinking (Hobbs 1980). As a result, much of what students do is "fact-level learning and not conceptualization" (Ehrenberg 1981). The Inclusion Process is designed to complement this knowledge-based curriculum with a process that leads to greater understanding and better learning. The process can be used with any subject matter content, but focuses on direct instruction of selected skills.

This focus on process rather than content (*how* to think rather than *what* to think) provides both the teacher and learner with frequent in-class opportunities to identify and apply content-appropriate thinking skills. Piaget (1972) and others have demonstrated that reasoning ability increases when opportunities for growth are provided. If incorporation of the Inclusion Process or any of the other approaches to improving student thinking continue to yield positive results, we can expect an exciting new direction for educational policy and practice: excellence in thinking as the overarching goal of education.

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